MECHATRONICS BOOK SERIES SYSTEM DESIGN AND SIGNAL PROCESSING

VOLUME 1

Editors
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CHAPTER 23

Electrooculography-Controlled Wheelchair

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23.1 Introduction

The electrooculography (EOG) is a technique for measuring and recording eye movements via a voltage difference between the cornea and retina. As the eye moves, the vector of this electric field changes with respect to a reference electrode. At least two biopotential channels are required when recording eye movements to assist in distinguishing eye movement potentials from other signal artifacts. The amplitude of the EOG signal is very small and varies from 0.05 mV to 3.5 mV with a frequency range of about 0 to 50Hz.

There are many disabled who depend on wheelchair to move around. Recently there has been a significant increase in the development of assistive technology for people with disabilities. The eye movement seems to have a big potential to be incorporated into the operation of wheelchair so as to assist the disabled to be more independent to manage their life.

23.2 System Background

There are quite a number of applications that utilize EOG signals as a mean to drive the system. [1] reported the use of EOG in tracking problem for Human Computer Interface (HCI). The objective of this system is to position the cursor on the screen from the information recorded from the user.s EOG signals. The interface system works exactly like the mouse-movement to control a cursor in a computer. Through the work of [2], they presented a guided scheme to control a wheelchair. The command schemes are affected by means of the following ocular actions: UP: The wheelchair moves forward, DOWN: The wheelchair moves backward, RIGHT: The wheelchair moves to the right, LEFT: The wheelchair moves to the left.

[3] developed vehicle driver drowsiness detection system using EOG. The system tracks the eye motion during drowsiness. However, the system requires high computing power due to real time video processing. It is reported by [4] that by using the dynamic natural eye orientation signal, one could control the orientation of artificial eye more naturally. A small servomotor is used to drive the artificial eye.

23.3 System Description

In general, the first part of the system is to extract the EOG signal by means of electrodes and signal conditioning circuit. The analog signal is then digitized before being transmitted to the wheel chair control system. Here, the signal will be manipulated to generate the control command to the motor in order to move the wheelchair accordingly.

In particular, to obtain the HEOG signal using one channel signal acquisition system, a pair of electrodes is used to capture the signal as input to the instrumentation amplifier (INA 126). The difference between these two inputs is amplified by the instrumentation amplifier. The gain of the instrumentation amplifier can be adjusted from 5 to 10000. The requireiment to amplify the EOG signal is because the actual amplitude of the signal is very small (0.05-3.5mV). According to